WHAT IS CLAIMED IS:

1. An apparatus comprising:

an optical modulator comprising

a ridge;

a signal electrode on the ridge, the signal electrode having an interaction length which is at least 41 mm; and

a ground electrode, wherein a gap width between the ground electrode and the signal electrode is at least 44 μm.

2. An apparatus as in claim 1, wherein the optical modulator has a single drive structure.

3. An apparatus as in claim 1, wherein the optical modulator has a single drive structure and the signal electrode is supplied with a drive voltage of at most 3.7 V.

4. An apparatus as in claim 1, wherein the optical modulator has a dual drive structure.

5. An apparatus as in claim 1, wherein the optical modulator has a dual drive structure, the signal electrode is supplied with a drive voltage of at most 1.7 V, the gap width is at least 56 μm, and the ground electrode has a thickness of at least 11 μm.

6. An apparatus as in claim 1, wherein the signal electrode is supplied with a drive voltage of at most 1.5 V, the gap width is at least 62 μm, and the ground electrode has a thickness of at least 28 μm.

7. An apparatus as in claim 1, wherein the ground electrode has a thickness of at most 50 μm.

8. An apparatus as in claim 1, wherein the optical modulator is a 40 Gbps optical modulator.

9. An apparatus as in claim 2, wherein the optical modulator is a 40 Gbps optical modulator.

10. An apparatus as in claim 3, wherein the optical modulator is a 40 Gbps optical modulator.

11. An apparatus as in claim 4, wherein the optical modulator is a 40 Gbps optical modulator.

12. An apparatus as in claim 5, wherein the optical modulator is a 40 Gbps optical modulator.

13. An apparatus as in claim 6, wherein the optical modulator is a 40 Gbps optical modulator.

14. An apparatus as in claim 1, wherein the optical modulator further comprises a $LiNbO_3$ substrate on which the optical modulator is based.

15. An apparatus as in claim 1, wherein the optical modulator comprises a z-cut $LiNbO_3$ substrate on which the optical modulator is based.

16. An apparatus as in claim 2, wherein the optical modulator further comprises a $LiNbO_3$ substrate on which the optical modulator is based.

17. An apparatus as in claim 2, wherein the optical modulator comprises a z-cut $LiNbO_3$ substrate on which the optical modulator is based.

18. An apparatus as in claim 4, wherein the optical modulator further comprises a $LiNbO_3$ substrate on which the optical modulator is based.

19. An apparatus as in claim 4, wherein the optical modulator comprises a z-cut $LiNbO_3$ substrate on which the optical modulator is based.

20. An apparatus as in claim 8, wherein the optical modulator further comprises a $LiNbO_3$ substrate on which the optical modulator is based.

21. An apparatus as in claim 8, wherein the optical modulator comprises a z-cut $LiNbO_3$ substrate on which the optical modulator is based.

22. An apparatus as in claim 1, wherein the optical modulator further comprises:

a buffer layer between the signal electrode and the ridge.

23. An optical modulator for optically modulating a light, comprising

a substrate;

an optical waveguide through which the light travels;

a ridge changing an elevation of the optical waveguide with respect to the substrate;

a ground electrode;

a signal electrode on the ridge, a gap width between the ground electrode and the signal electrode being at least 44 μm, the signal electrode having an interaction length with respect to the optical waveguide of at least 41 mm, a drive signal supplied to the signal electrode causing an electric field to be produced along the optical waveguide as the light travels through the optical waveguide, to optically modulate the light.

24. An optical modulator as in claim 23, wherein the optical modulator has a single drive structure.

25. An optical modulator as in claim 23, wherein the optical modulator has a single drive structure and the signal electrode is supplied with a drive signal having a voltage of at most 3.7 V.

26. An optical modulator as in claim 23, wherein the optical modulator has a dual drive structure.

27. An optical modulator as in claim 23, wherein the optical modulator has a dual drive structure, the signal lectrode is supplied with a drive signal

having a voltage of at most 1.7 V, the gap width is at least 56 μm, and the ground electrode has a thickness of at least 11 μm.

28. An optical modulator as in claim 23, wherein the signal electrode is supplied with a drive signal having a voltage of at most 1.5 V, the gap width is at least 62 μm, and the ground electrode has a thickness of at least 28 μm.

29. An optical modulator as in claim 23, wherein the ground electrode has a thickness of at most 50 μm.

30. An optical modulator as in claim 23, wherein the optical modulator is a 40 Gbps optical modulator.

31. An optical modulator as in claim 24, wherein the optical modulator is a 40 Gbps optical modulator.

32. An optical modulator as in claim 25, wherein the optical modulator is a 40 Gbps optical modulator.

33. An optical modulator as in claim 26, wherein the optical modulator is a 40 Gbps optical modulator.

34. An optical modulator as in claim 27, wherein the optical modulator is a 40 Gbps optical modulator.

35. An optical modulator as in claim 28, wherein the optical modulator is a 40 Gbps optical modulator.

36. An optical modulator as in claim 23, wherein the substrate is a $LiNbO_3$ substrate.

37. An optical modulator as in claim 23, wherein the substrate is a z-cut $LiNbO_3$ substrate.

38. An optical modulator as in claim 24, wherein the substrate is a $LiNbO_3$ substrate.

39. An optical modulator as in claim 24, wherein the substrate is a z-cut $LiNbO_3$ substrate.

40. An optical modulator as in claim 26, wherein the substrate is a $LiNbO_3$ substrate.

41. An optical modulator as in claim 26, wherein the substrate is a z-cut $LiNbO_3$ substrate.

42. An optical modulator as in claim 30, wherein the substrate is a $LiNbO_3$ substrate.

43. An optical modulator as in claim 30, wherein the substrate is a z-cut $LiNbO_3$ substrate.

44. An optical modulator as in claim 23, further comprising:

a buffer layer between the signal electrode and the ridge.

45. An optical modulator for optically modulating a light, comprising

a substrate;

an optical waveguide through which the light travels;

a ridge changing an elevation of the optical waveguide with respect to the substrate;

first and second ground electrodes;

a signal electrode on the ridge and positioned between the first and second ground electrodes, a gap width between the first ground electrode and the signal electrode, and between the second ground electrode and the signal electrode, being at least 44 μm, the signal electrode having an interaction length with respect to the optical waveguide of at least 41 mm, a drive signal supplied to the signal electrode causing an

electric field to be produced along the optical waveguide as the light travels through the optical waveguide, to optically modulate the light.

46. An optical modulator as in claim 45, wherein the optical modulator has a single drive structure.

47. An optical modulator as in claim 45, wherein the optical modulator has a single drive structure and the signal electrode is supplied with a drive signal having a voltage of at most 3.7 V.

48. An optical modulator as in claim 45, wherein the optical modulator has a dual drive structure.

49. An optical modulator as in claim 45, wherein the optical modulator has a dual drive structure, the signal electrode is supplied with a drive signal having a voltage of at most 1.7 V, the gap width is at least 56 μm, and the first and second ground electrodes each have a thickness of at least 11 μm.

50. An optical modulator as in claim 45, wherein the signal electrode is supplied with a drive signal having a voltage of at most 1.5 V, the gap width is at least 62 μm, and the first and second ground electrodes each have a thickness of at least 28 μm.

51. An optical modulator as in claim 45, wherein the first and second ground electrodes each have a thickness of at most 50 μm.

52. An optical modulator as in claim 45, wherein the optical modulator is a 40 Gbps optical modulator.

53. An optical modulator as in claim 46, wherein the optical modulator is a 40 Gbps optical modulator.

54. An optical modulator as in claim 47, wherein the optical modulator is a 40 Gbps optical modulator.

55. An optical modulator as in claim 48, wherein the optical modulator is a 40 Gbps optical modulator.

56. An optical modulator as in claim 49, wherein the optical modulator is a 40 Gbps optical modulator.

57. An optical modulator as in claim 50, wherein the optical modulator is a 40 Gbps optical modulator.

58. An optical modulator as in claim 45, wherein the substrate is a $LiNbO_3$ substrate.

59. An optical modulator as in claim 45, wherein the substrate is a z-cut $LiNbO_3$ substrate.

60. An optical modulator as in claim 46, wherein the substrate is a $LiNbO_3$ substrate.

61. An optical modulator as in claim 46, wherein the substrate is a z-cut $LiNbO_3$ substrate.

62. An optical modulator as in claim 48, wherein the substrate is a $LiNbO_3$ substrate.

63. An optical modulator as in claim 48, wherein the substrate is a z-cut $LiNbO_3$ substrate.

64. An optical modulator as in claim 52, wherein the substrate is a $LiNbO_3$ substrate.

65. An optical modulator as in claim 52, wherein the substrate is a z-cut $LiNbO_3$ substrate.

66. An optical modulator as in claim 45, further comprising:

a buffer layer between the signal electrode and the ridge.

67. An optical modulator for optically modulating a light, comprising

a z-cut $LiNbO_3$ substrate;

an optical waveguide through which the light travels;

a ridge changing an elevation of the optical waveguide with respect to the substrate;

first and second ground electrodes;

a signal electrode on the ridge and positioned between the first and second ground electrodes, a gap width between the first ground electrode and the signal electrode, and between the second ground electrode and the signal electrode, being at least 44 μm, the signal electrode having an interaction length with respect to the optical waveguide of at least 41 mm; and

a buffer layer between the signal electrode and the ridge, wherein a drive signal supplied to the signal electrode causes an electric field to be produced along the optical waveguide as the light travels through the optical waveguide, to optically modulate the light.

68. An optical modulator as in claim 67, wherein the optical modulator has one of the group consisting of a single drive structure and a dual drive structure.

69. An optical modulator as in claim 67, wherein the optical modulator is a 40 Gbps optical modulator.

70. An optical modulator as in claim 68, wherein the optical modulator is a 40 Gbps optical modulator.

71. An optical modulator comprising

a crystal substrate that exhibits an electro-optic effect;

an optical waveguide through which a light travels;

a ridge changing an elevation of the optical waveguide with respect to the substrate;

first and second ground electrodes;

a signal electrode on the ridge and between the first and second ground electrodes, a gap width between the signal electrode and the first ground electrode, and between the signal electrode and the second ground electrode, being at least 44 μm, the signal electrode having an interaction length with respect to the optical waveguide of at least 41 mm, wherein

the light traveling through the optical waveguide is phase-matched with a microwave signal traveling through the signal electrode, and

characteristic impedance of the signal electrode is set within a range where microwave reflection is limited below a predetermined level, to thereby optically modulate the light.

72. An optical modulator as in claim 71, wherein the optical modulator has one of the group consisting of a single drive structure and a dual drive structure.

73. An optical modulator as in claim 71, wherein the optical modulator is a 40 Gbps optical modulator.

74. An optical modulator as in claim 72, wherein the optical modulator is a 40 Gbps optical modulator.

75. An optical modulator as in claim 71, wherein the substrate is a $LiNbO_3$ substrate.

76. An optical modulator as in claim 71, wherein the substrate is a z-cut $LiNbO_3$ substrate.

77. An optical modulator as in claim 72, wherein the substrate is a $LiNbO_3$ substrate.

78. An optical modulator as in claim 72, wherein the substrate is a z-cut $LiNbO_3$ substrate.

79. An optical modulator as in claim 71, further comprising:

a buffer layer between the signal electrode and the ridge.

80. An optical modulator comprising

a z-cut $LiNbO_3$ substrate;

an optical waveguide through which a light travels;

a ridge changing an elevation of the optical waveguide with respect to the substrate;

first and second ground electrodes;

a signal electrode on the ridge and between the first and second ground electrodes, a gap width between the signal electrode and the first ground electrode, and between the signal electrode and the second ground electrode, being at least 44 μm, the signal electrode having an interaction length with respect to the optical waveguide of at least 41 mm, and

a buffer layer between the signal electrode and the ridge, wherein

the light traveling through the optical waveguide is phase-matched with a microwave signal traveling through the signal electrode, and

characteristic impedance of the signal electrode is set within a range where microwave reflection is limited below a predetermined level, to thereby optically modulate the light.

81. An optical modulator as in claim 80, wherein the optical modulator has one of the group consisting of a single drive structure and a dual drive structure.

82. An optical modulator as in claim 80, wherein the optical modulator is a 40 Gbps optical modulator.

83. An optical modulator as in claim 81, wherein the optical modulator is a 40 Gbps optical modulator.

84. An apparatus comprising:

a 40 Gbps optical modulator comprising

a substrate;

a signal electrode formed on the substrate, the signal electrode having a base with a width W; and

a ground electrode, a gap width S existing between the ground electrode and the signal electrode, wherein the ratio S/W is greater than or equal to 8.

85. An apparatus as in claim 84, wherein the substrate is a $LiNbO_3$ substrate.

86. An apparatus as in claim 84, wherein the substrate is a z-cut $LiNbO_3$ substrate.

87. An apparatus as in claim 84, wherein the optical modulator has one of the group consisting of a single drive structure and a dual drive structure.

88. An apparatus comprising:

a 40 Gbps optical modulator comprising

a substrate;

first and second ground electrodes formed on the substrate; and

a signal electrode formed on the substrate between the first and second ground electrodes, a gap width S existing between the first ground electrode and the signal electrode, and between the second ground electrode and the signal electrode, the signal electrode having a base with a width W, wherein the ratio S/W is greater than or equal to 8.

89. An apparatus as in claim 88, wherein the substrate is a $LiNbO_3$ substrate.

90. An apparatus as in claim 88, wherein the substrate is a z-cut $LiNbO_3$ substrate.

91. An apparatus as in claim 88, wherein the optical modulator has one of the group consisting of a single drive structure and a dual drive structure.

92. A method of designing an optical modulator which performs electrical-to-optical conversion by modulating a light beam with a microwave signal, the method comprising the steps of:

(a) defining an allowable range of characteristic impedance within which microwave reflection is limited below a predetermined level;

(b) performing phase matching by making effective refraction index for the microwave signal agree with that for the light beam;

(c) defining a first relationship that associates the thickness of ground electrodes with the width of a gap between a signal electrode and the ground electrodes, based on a result of said phase matching step (b);

(d) defining a second relationship that associates ground electrode thickness with the gap width within the allowable range;

(e) determining an acceptable range of the gap width and the ground electrode thickness, based on the first and second relationships;

(f) plotting the driving voltage and an interaction length of the signal electrode within the acceptable range; and

(g) obtaining optimal values of the gap width, interaction length, drive voltage, and ground electrode thickness by increasing the gap width together with the interaction length to reduce the drive voltage and loss of high-frequency components of the microwave signal.

93. The method according to claim 92, wherein:
the optical modulator operates at a rate of at least 40 Gbps;
the interaction length is at least 41 mm; and
the gap width is at least 44 μm.

94. The method according to claim 93, wherein:
the drive voltage is at most 1.7 V;
the gap width is at least 56 μm; and
the ground electrode thickness is at least 11 μm.

95. The method according to claim 93, wherein:
the drive voltage is at most 1.5 V;

the gap width is at least 62 μm; and

the ground electrode thickness is at least 28 μm.

96. The method according to claim 93, wherein the ground electrode thickness is at most 50 μm.

97. The method according to claim 93, wherein the signal electrode has either single-drive structure or dual-drive structure.